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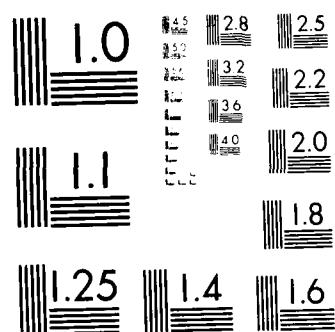
THE RELATIONSHIP BETWEEN RADIATION SENSITIVITY AND  
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SCHOOL OF ENGINEERING D L KINSER ET AL. 01 MAR 88  
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19 ABSTRACT (Continue on reverse if necessary and identify by block number) This program examined the role of glass processing upon subsequent radiation effects with particular focus upon optical absorption centers. The results have indicated a number of strategies appropriate for the mitigation of radiation induced darkening of optical components. The fundamental understanding of the relationship between glass processing variables and atomic defects in glasses has permitted these advances.							
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THE RELATIONSHIP BETWEEN  
RADIATION SENSITIVITY AND REDOX EQUILIBRIA

Final Report

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**Abstract:**

This program examined the role of glass processing upon subsequent radiation effects with particular focus upon optical absorption centers. The results have indicated a number of strategies appropriate for the mitigation of radiation induced darkening of optical components. The fundamental understanding of the relationship between glass processing variables and atomic defects in glasses has permitted these advances.

**Statement of Research Problem:**

The work conducted under this program has focused upon the role of glass processing upon the defect concentrations in as-prepared glasses of various types. The subsequent interaction of those defects with ionizing radiation has also been monitored using experimental techniques such as electron paramagnetic resonance (EPR), DC conductivity, optical absorption, and optical bleaching. A number of these studies have also included annealing studies of the defects so as to ascertain the thermal stability of the various defects in the irradiated glasses.

**Overview of Results Obtained:**

The bulk of the results obtained on this program have been reported in the published literature in the 21 papers published to date. At least one additional paper is anticipated as a result of the work conducted under this program.

The results of this program have outlined the salient variables involved in the melting of a glass as they influence the atomic defect population of the resulting glass. Such processing variables include the melting atmosphere, temperature, quenching rate and subsequent annealing processes. It has become clear that atomic defects of two types arise in glasses. The first of these defects is the chemical defect such as non-stoichiometry or an impurity atom in the glass. The missing atom (nonstoichiometry) or an atom of the wrong valence (impurity atom) each result in an associated defect which is a site for electron trapping in subsequent ionizing radiation environments. This is one source of radiation induced damage which can be mitigated by processing to avoid nonstoichiometry or impurity atoms.

The second class of atomic defect is associated with disorder in the glass. This can be exemplified by an oxygen atom which is ordinarily two coordinated or connected to two silicon atoms. If an oxygen is triply coordinated or singly coordinated, a local disorder arises. This defect is a simple consequence of structural disorder at a particular atom site. A classic example of such a defect is the intimate valence alternation pair (IVAP) first hypothesized in chalcogenide glasses but observed in SiO<sub>2</sub> during the course of this research.

Publications Resulting from this Research:

1. "Effects of Densification Conditions on the Defect Center Concentration in Germanium-Doped Silica Optical Fiber Preforms", Journal of Non-Crystalline Solids, 69 January 1985, pgs. 293-298, G. Kordas, D. L. Kinser, and R. A. Weeks.
2. "The Effect of Melt Temperature on the DC Conductivity of GeO<sub>2</sub> Glasses," Journal of Applied Physics, 57, (2), January 1985, pp. 345-350, R. Magruder, R. Weeks, J. Jackson, and D. L. Kinser.
3. "Fusion Temperature Effects on the Annealing Behavior of GeO<sub>2</sub> Glasses as Measured by the DC Resistivity", Journal of Non-Cryst. Solids, Vol. 71, May 1985, pp. 95 - 102, R. Magruder, III, D. L. Kinser, and R. Weeks.
4. "Paramagnetic Conduction Electrons in Germanium Sulfide Glasses," Journal of Non-Crystalline Solids, Vol. 71, May 1985 pp. 157-161, G. Kordas, D. L. Kinser, and R. Weeks.
5. "Sol-Gel Glasses by Non-Aqueous Processes", Journal of Non-Cryst. Solids, Vol. 71, May 1985, pp. 361-371, F. Bonner, D. L. Kinser, and G. Kordas.
6. "Electron-Spin-Resonance (ESR) Study of Sol-Gel Glasses", Journal of Non-Cryst. Solids, Vol 71 (1985) 327-333, G. Kordas, R. A. Weeks and L. Klein.
7. "Preparation Effects on the UV Optical Properties of GeO<sub>2</sub> Glasses", Journal of Applied Physics, Vol. 58, No. 6, Sept., 1985, pp. 2308-2311, J. Jackson, M. Wells, R. Magruder, III, G. Kordas, R. Weeks, and D. L. Kinser.
8. "Dependence of Sodium Ion Mobility upon Melt Atmosphere in GeO<sub>2</sub> Glasses", Communications of the American Ceramic Society. January 1986, Vol. 69, No.1, C10 & C11, R.H. Magruder, III, D. L. Kinser, and R. A. Weeks.
9. "The Effects of Annealing of the GeO<sub>2</sub> Glasses on their Paramagnetic Center Concentration" G. Kordas and R. Weeks. Collected Papers, XIV International Congress on Glass, (1986) pp 17-23.
10. "The Effects of Heat Treatments on the Magnetic and Optical Properties of Fe Ions Implanted in SiO<sub>2</sub> Glass" R. A. Weeks, Glenn Whichard, George Kordas and B. R. Appleton, Collected Papers, XIV International Congress on Glass, 1986 pgs 236-243.
11. "The Nature of the Paramagnetic States in SiO<sub>2</sub>-GeO<sub>2</sub> Sol-Gel Glasses" G. Kordas and S. P. Mukherjee, Materials Research Symposia 61 (1986) pgs 413-417.

12. "The Structure of  $\text{SiO}_2$ -Sol-Gel Glasses Produced from Gels with Various Mole-Water per Mole-TEOS Ratios" G. Kordas" Materials Research Symposia 61 (1986) 419-423.

13. "Ion Transport as a Technique for Studying Glass Structure," Proceedings of the XIV International Congress on Glass, New Delhi, India, March 1986, Vol.I, pp. 24-31, D. L. Kinser, R. H. Magruder, III, Biprodas Dutta, and John M. Jackson.

14. "Experimental Evidence for the Existence of Intimate Valence Alteration Pair Defects in  $\text{GeO}_2$  Glasses," Proceedings of VIth International Conference on The Physics of Non-Crystalline Solids, July 6-10, 1987, Kyoto, Japan, J. Non-Cryst. Solids, 95, 389-396 (1987), B. Dutta, R. Magruder, D. L. Kinser, and R. Weeks.

15. "Raman Studies of  $\text{GeO}_2$  Glass Preparation History," Journal of Non-Crystalline Solids, 94, 56-61 (1987), R. Magruder, III, Steve Morgan, R. A. Weeks and D. L. Kinser.

16. "Computerized Apparatus for Thermally Stimulated Current (TSC) Measurements", Review of Scientific Instruments, June, 1987, pp. 1003-1008, J. M. Jackson, D. L. Kinser and Biprodas Dutta.

17. "Optical Properties of  $\text{GeO}_2$ ," Physical Review B, Vol. 36, No. 11, October 15, 1987, pp. 6132-6134, N. M. Ravindra, D. L. Kinser, and R. A. Weeks.

18. "Effects of Liquid Equilibration Temperature,  $T_\phi$ , on the Properties of Germania Glass: A Review," to be published in Proceedings of the 2nd International Conference on Effects of Modes of Formation on the Structure of Glass with R. A. Weeks.

19. "Microstructural Studies of Colloidal Silica Derived Aerogels" Ronald Alan Quarles MS Thesis, Vanderbilt University, December. 1986

20. "Thermal Analysis of the Radiation Induced Conductivity in  $\text{GeO}_2$  Glasses," submitted to Journal of Non-Crystalline Solids, December 1987, R.H. Magruder, D. L. Kinser, R.A. Weeks, J.M. Jackson and E. Sonder.

21. "Electrical Conduction and Polarization in Lead Silicate Glasses," submitted to Journal of American Ceramic Society, December 1987, B. Dutta, D.L. Kinser, R. H. Magruder, and R.A. Weeks.

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